Description

Device for producing a focused light flux

The invention relates to a device for producing a focused light flux.

In order to convey information to vehicle drivers without the need for them to avert their gaze from the road to be driven or the air space to be flown, so-called head-up displays have become known that are used to fade in an image representing information into the windshield of a vehicle. In order for the image still to remain visible in bright ambient light, there is an additional need for it to have a high luminous density. Focused light fluxes are also required for other illumination purposes, for example as reading lamps or as emitters for show-windows and expositions.

It is therefore an object of the invention to produce a light flux with the aid of devices that exhibit, in particular, a low overall size and low weight, consume, and/or output as heat, as little power loss as possible, and are therefore also suitable for operation in a vehicle.

This object is achieved according to the invention by providing a light source consisting of a light-emitting diode matrix, and by virtue of the fact that an optical device for focusing and scattering the light produced by the light-emitting diodes is arranged between the light source and a light exit opening, in that the device for focusing and scattering comprises a grid reflector that respectively forms a light channel for a matrix point whose walls are reflecting, and in that the end of in each case one light channel that faces the light source includes a positive lens.

In the case of the device according to the invention, it has proved to be advantageous when a matrix point is formed in each case

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from a number of light-emitting diodes, which can also be of different color. Furthermore, the invention is not restricted to the application of in each case a single lens per light channel.

A cost effective fabrication of the device according to the invention is possible when the positive lenses of all the light channels are integrally connected to a plate arranged between the light source and the grid reflector. However, this plate permits an undesired conduction of light in a transverse direction, and this can be prevented when the positive lenses are integrally connected in groups to webs arranged between the light source and the grid reflector.

An advantageous refinement of the invention consists in that the radii of curvature of the lens differ in different directions (astigmatic lenses). The light distribution can thereby be improved, particularly in elongated light exit openings.

Another advantageous refinement consists in that an image reproduction apparatus including light valves is arranged at the light exit opening. This development renders possible a compact device for producing high-resolution images of high luminous density and with a uniform distribution of luminous density over the entire image area. The device for focusing and scattering ensures in this case that the light produced by the light-emitting diodes is concentrated onto the surface of the image reproduction apparatus without the individual light-emitting diodes being disturbingly imaged. A preferred field of application of the device according to the invention are graphical head-up displays for vehicle applications.

The image reproduction apparatus lends the device according to the invention a few more advantages, which

are set forth below. Thus, the coordination between RGB light source

and color display renders possible the display of graphic color images in a head-up display in conjunction with adequate luminous density. A uniform distribution of color and luminous density of the background lighting on the area of the liquid crystal display is achieved in cooperation with the reflector and the lens.

Configurable image contents can be displayed in color in the liquid crystal color display. The image content can therefore be adapted to the driving situation. The installation space for the entire image generating device is only a few cubic centimeters in the case of the example executed in practice. It is possible to influence the color space respectively to be displayed by selecting the colors of the light-emitting diodes and of the associated display. For example, instead of an RGB light-emitting diode matrix it is possible to select a red/green light-emitting diode matrix and, in a corresponding way, to replace the blue filter elements by green ones in the liquid crystal display. This results in a restricted color space with a luminous density that has been further substantially increased.

The invention permits numerous embodiments. A number of them are illustrated schematically in the drawing with the aid of a number of figures, and described below. In the drawing:

figure 1 shows a section through an exemplary embodiment,

figure 2 shows a plan view of the grid reflector for the exemplary embodiment according to figure 1,

figure 3 shows a section through a further exemplary embodiment,

figure 4 shows an enlarged illustration of a detail from figure 1, for the purpose of explaining various details,

figure 5 shows an enlarged illustration of a detail of another exemplary embodiment, and

figure 6 shows a part of the lens matrix.

Provided as light source in the exemplary embodiment according to figures 1 and 2 is a matrix of 4 x 8 groups of in each case four light-emitting diodes 1 that are mounted on a support 2. Webs 3 whose oblique surface serves as reflector are located between the groups.

A lens array 4 adjoined by a grid reflector 5 lies over the light source 1, 2, 3.

The webs 3, the lens matrix 4 and the obliquely running surfaces 6 of the grid reflector 5 effect uniform light distribution. In order to avoid shading by the webs 7 of the reflector 5, a frame 8 is provided that effects a spacing between the reflector 5 and the liquid crystal display 9. Located below the liquid crystal display 9 is a diffusing screen 10 which serves the purpose of further improving the uniformity of the backlighting of the liquid crystal display 9.

The frame 8 positions the liquid crystal display obliquely such that the light incident from above is not reflected in the same direction in which the light also leaves the liquid crystal display in order to reach the viewer.

Figure 2 shows the device according to figure 1 with the liquid crystal display 9 removed and with the diffusing screen 10 removed. The light-emitting diodes 1 are visible per se through the lens matrix 4 in the case of the illustration according to figure 2. However, for the sake of simplicity a corresponding distortion of the light-emitting diodes 1 has not been illustrated.

The exemplary embodiment according to figure 3

illustrates an illuminating device where the light exit opening comprises

a glass plate 18 resting on a frame 17. Otherwise, this exemplary embodiment is constructed like that according to figure 1.

Figure 4 essentially illustrates an enlarged detail from figure 1, and serves to explain details of the liquid crystal display and of the light source. The liquid crystal display 9 has a liquid crystal 13 and a color filter 14 between two glass plates 11, 12. Said color filter consists of an array of three differently colored color points, which is marked in figure 4 by different hatching. Control electrodes (not illustrated) are provided in a fashion correlating with the array of the color filter, and form a light valve in each case with the liquid crystal. Located outside the glass plates 11, 12 are polarizers 15, 16 with mutually perpendicular polarization planes.

The light source briefly described in conjunction with figure 1 is illustrated in figure 4, likewise in more detail.

Four light-emitting diodes 1 are arranged on a submount 20 in a fashion raised in the middle of a hole formed by webs 3. The light-emitting diodes are connected to lines 25 via bonding wires 21 that are illustrated only schematically by hatching the area they occupy. In a preferred embodiment, one of the light-emitting diodes shines red, two shine green, and the fourth shines blue. In this arrangement, light is mixed to form white. The space between the submount 20 and the webs 3 is filled up with a white potting compound 22 whose surface 24 serves as reflector for the light emitted laterally from the light-emitting diodes 1. A transparent potting compound 23 prevents the formation of a cavity.

In the case of the exemplary embodiment illustrated in

figure 4, the connection between the light source 1, 2, 3 and the lens matrix 4

is performed via a layer 26 made from silicone gel, a PCF layer 27 and a suitable adhesive 28.

The PCF layer 27 has the effect that of the light which is produced by means of the light-emitting diodes, only that is allowed through which is polarized in the direction of the lower polarizer 15, so that no light is lost by the polarization in the PCF layer 27. The differently polarized light is reflected by the PCF layer 27 and subsequently re-emitted from the surface 24. Of this, the component with the appropriate polarization in turn additionally passes through the PCF layer 27 such that, overall, the PCF layer contributes to increasing the brightness.

Figure 5 shows an exemplary embodiment without a PCF layer. The illustrated detail at the edge of the device is also to be found in figure 5.

Figure 6 shows a lens matrix 31 with eight lenses that are held together by webs 32. Four of the lens matrices illustrated in figure 6 are arranged next to one another in the exemplary embodiment according to figures 4 and 5.

Patent Claims

1. A device for producing a focused light flux, characterized in that a light source consisting of a light-emitting diode matrix (1, 2, 3) is provided, in that an optical device for focusing and scattering the light produced by the light-emitting diodes is arranged between the light source and a light exit opening (9, 18), in that the device for focusing and scattering comprises a grid reflector (5) that respectively forms a light channel for a matrix point whose walls (6) are reflecting, and in that the end of in each case one light channel that faces the light source (1, 2, 3) includes a positive lens (4).

2. The device as claimed in claim 1, characterized in that the positive lenses (4) of all the light channels are integrally connected to a plate arranged between the light source (1, 2, 3) and the grid reflector (5).

3. The device as claimed in claim 1, characterized in that the positive lenses (4) are integrally connected in groups to webs arranged between the light source (1, 2, 3) and the grid reflector (5).

4. The device as claimed in one of the preceding claims, characterized in that the radii of curvature of the lens differ in different directions (astigmatic lenses).

5. The device as claimed in one of the preceding claims, characterized in that an image reproduction apparatus (9) including light valves is arranged at the light exit opening.